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AUTHOR Rodriguez, Alberto J.

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ABSTRACT

This paper provides a meta-analysis of current trends in student achievement in science by socioeconomic status and gender within ethnic groups. Data from a variety of sources, such as the National Assessment of Education Progress (NAEP) and the National Education Longitudinal Study (NELS) reports were used. In addition, trends in student achievement from NAEP and NELS were contrasted with trends from college-entrance exams, such as the Scholastic Aptitude Test (SAT) and the American College Tests (ACT). Finally, the observed trends in achievement were further contrasted with those emerging from the College Boards Advanced Placement (AP) Exams scores in science. The results of this analysis indicate that there is cause for cautious celebration. There has been some improvement in student achievement and participation in science. However, it is alarming that the observed pattern of achievement by SES and gender within ethnic groups is consistent and congruent over time and across national studies and reports regardless of age and grade level. That is, it was observed that U.S. Asian and Anglo-European students consistently outperformed underserved students. Most U.S. Latinos and First Nations students are consistently in the middle of the achievement scale, whereas Puerto Ricans, and U.S. African students continue to be at the bottom of the scale. A closer look at the quality of the achievement gaps (i.e., achievement and participation by gender within ethnic groups) and not just at the size of the gap (strict score comparisons) indicates that much more could be learned from this form of analysis. In other words, more useful information from achievement scores was revealed when achievement by gender within each ethnic group was used as the unit of analysis instead of using the achievement scores of Asian and Anglo-European males as the unit of analysis. For example, I found that in the last five years, and in spite of their low numbers, the absolute number of U.S. African females who outperformed their male counterparts in AP science tests has been increasing substantially. Therefore, this study points to the importance of conducting a longitudinal study with underserved

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students who have been successful in science in spite of the variety of institutional and social obstacles they continue to face. By better understanding the factors influencing success in science courses from the traditionally underserved students' points of view, educators will be able to develop more effective and responsive intervention programs. (Contains 34 references.) (Author)

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University of Wisconsin-Madison • National Center for Improving Science Education

Research Monograph No. 3

Counting the Runners Who Don't Have Shoes: Trends in Student Achievement in Science by Socioeconomic Status and Gender Within Ethnic Groups

Alberto J. Rodriguez

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Counting the Runners Who Don't Have Shoes: Trends in Student Achievement in Science by Socioeconomic Status and Gender Within Ethnic Groups

Alberto J. Rodriguez

National Institute for Science Education
University of Wisconsin-Madison

February 1997

About the Author

Alberto J. Rodriguez is Assistant Professor of Science Education in the Department of Curriculum and Instruction at the University of Wisconsin-Madison and a Research Associate for the National Institute for Science Education's Policy Analysis of Systemic Reform team. His research interests include equity issues and the intersection of multiculturalism and social constructivism in science teaching and learning.

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Terms Used

The labels we use to place individuals or groups of individuals are embedded in cultural and historical capital. For example, institutions use labels for convenience and simplicity--a way to distinguish "the Other" from the norm. However, commonly used "people labels" are colonial and emphasize superficial physical differences. For instance, even though colonial terms such as "Master" or "Patron" are unacceptable today, terms such "Black," "White," "Indian" and "race" endure. Furthermore, even a new term was invented when the colonial use of "Spanish," "mulato'" or "mestizo" was not appropriate to classify Latinos/as. Hence, the term "Hispanic" (meaning "of Spain") was created by the U.S. government in the late 1970s.

In this paper, I refer to individuals by bringing attention to their ethnic and cultural heritage instead of bringing attention to the color of their skin. Even though, the terms I use may not accurately represent the cultural diversity within the ethnic groups considered in this paper, I believe they are more inclusive. In any case, my goal is to celebrate the fact that we all have ethnic roots that cut across artificial boundaries. Therefore, I use the following terms throughout:

Latino/Latina *instead of* Hispanic
African *instead of* Black *or* African American
First Nations *instead of* Indian *or* Native American
Anglo-European *or* Anglo *instead of* White
Asian
ethnicity *instead of* race
underserved *or* underrepresented *instead of* minority

In addition, I do not refer to individuals born in the United States of America as "Americans." Latinos used the term "Americano" (American) across the continent to celebrate a spirit of solidarity. This spirit has deep historical roots beginning with the wars of independence from colonial rule to the creation of the Organization of American States (OAS). A good example of what I mean by spirit of solidarity is the OAS. The origin of this organization predates the United Nations. The OAS is based on the ideals of Simon Bolivar—the Latino who led the liberation of five South American countries from the Spanish Monarchy.

Hence, Canadians, Mexicans, Costa Ricans, and individuals from the U.S. are all "Americans." Since I cannot use the term "American" to refer to individuals born in the United States, I use the term "U.S." in front of the word describing the individual's ethnic roots. For example, instead of "Black" or "African American," I use the words "U.S. African."

Abstract

This paper provides a meta-analysis of current trends in student achievement in science by socioeconomic status and gender within ethnic groups. Data from a variety of sources, such as the National Assessment of Educational Progress (NAEP) and the National Education Longitudinal Study (NELS) reports were used. In addition, trends in student achievement from NAEP and NELS were contrasted with trends from college-entrance exams, such as the Scholastic Aptitude Test (SAT) and the American College Test (ACT). Finally, the observed trends in achievement were further contrasted with those emerging from the College Board's Advanced Placement (AP) Exams scores in science. The results of this analysis indicate that there is cause for cautious celebration. There has been some improvement in student achievement and participation in science. However, it is alarming that the observed pattern of achievement by SES and gender within ethnic groups is consistent and congruent over time and across national studies and reports regardless of age and grade level. That is, it was observed that U.S. Asian and Anglo-European students consistently outperformed underserved students. Most U.S. Latinos and First Nations students are consistently in the middle of the achievement scale, whereas Puerto Ricans and U.S. African students continue to be at the bottom of the scale.

A closer look at the quality of the achievement gaps (i.e., achievement and participation by gender within ethnic groups) and not just at the size of the gap (strict score comparisons) indicates that much more could be learned from this form of analysis. In other words, more useful information from achievement scores was revealed when achievement by gender within each ethnic group was used as the unit of analysis instead of only using the achievement scores of Asian and Anglo-European males as the unit of analysis. For example, I found that in the last five years, and in spite of their low numbers, the absolute number of U.S. African females who outperformed their male counterparts in AP science tests has been increasing substantially. Therefore, this study points to the importance of conducting a longitudinal study with underserved students who have been successful in science in spite of the variety of institutional and social obstacles they continue to face. By better understanding the factors influencing success in science courses from the traditionally underserved students' points of view, educators will be able to develop more effective and responsive intervention programs.

Introduction

> Equity is the outcome of fundamental laws and policies which, when enforced, should guarantee fair treatment and access to resources and programs for all students. (Joint policy of the Washington State Board of Education, Office of the Superintendent of Public Instruction, and Washington State Human Rights Commission, 1994)

Does equity mean mediocrity? Those who attack affirmative action and other equity programs fear that traditionally disadvantaged groups in the sciences (any male from an ethnic group other than Anglo-European, women, the disabled, and the poor) are given unfair advantages through these social programs. Some fear that establishing equity in schools and the workplace equates with establishing mediocrity and diluting the curriculum so that "all" students could succeed. The over simplistic argument that everyone has a choice and that all that is needed to succeed is to work hard enough is echoed by Ward Connerly, a successful, U.S. African business executive and member of the University of California Board of Regents. Connerly spearheaded the 1995 Regents' resolution to outlaw hiring and admission practices based on ethnicity and gender (Barinaga, 1996). The University of California admits the top 12.5% of the state's high school graduates. However, only 4% of Latino/a and 5% of U.S. African students are in that group. (Meanwhile, 53% of the student population in California's K-12 schools is from traditionally underrepresented ethnic groups.)

This increasing incidence of equity-phobia is also fueled by the low standing of U.S. students in international achievement reports, such as the 1991 International Assessment of Educational Progress (Suter, 1996), the Third International Mathematics and Science Study (TIMSS), and the Survey of Mathematics and Science Opportunities (SMSO; National Research Council, 1996.) Even though TIMSS and SMSO researchers warn not to look at these studies as mere "horse races," the media and other interest groups use data from these studies to call for educational reform to maintain a strong economy and a strong military.

No doubt these are important concerns, but what creates a conundrum is the conflicting juxtapositions that permeate educational reform in the United States. In other words, while educational research points out equity as an instrumental process to substantially effect change in today's schools, we have politicians and some interest groups increasing their attacks on affirmative action and other social programs. While national reform efforts such as the National Science Foundation's Statewide Systemic Initiatives (Laguarda, 1994), Project 2061: Science for All Americans (American Association for the Advancement of Science, 1989), and the recently released National Science Education Standards (NRC, 1996b), all make equity one of the primary driving engines of their recommendations for reform, we are not quite certain how to assess equity and/or how to tell when an educational system (at the state, district, or local level) has achieved a state of functioning equity, that is, the process by which an institution's equity policies deliver in practice what it promises in paper.

Therefore, in light of the increasing pressures for educational reform at all levels, such as the extensive science education reform efforts spearheaded by the National Science Foundation's

Statewide, Urban and Rural Systemic Initiatives[1] (Shields, Corcoran, & Zucker, 1994), there is a need for greater clarity on the present state of student achievement in science. Moreover, in regard to equity, there is a need to better understand how the achievement of traditionally underserved students has changed in the last few years.

We are now in a good position to estimate how student achievement in the U.S. has changed since the release of the eye-opening report *A Nation at Risk: The Imperative for Education Reform* (1983), prepared by the National Commission on Excellence in Education. The Commission's report got a great deal of attention as it demonstrated to the general public and policymakers how the U.S. was falling behind on international assessments in science and mathematics. The Commission charged that one of the main reasons "the rising tide of mediocrity" was flooding U.S. schools was the small number of required courses in science and mathematics. The Commission also claimed that the poor performance of U.S. students on national tests could also be improved if all students spent more time learning science and mathematics.

In 1992, Blank and Engler took stock of how far we have moved since the *Nation at Risk* report. Two of their questions were: (1) Are students receiving more instruction in science and mathematics now compared to 10 years ago? and (2) Has student achievement in science and mathematics improved? The answer to the first question is very positive, mainly due to the fact that most states implemented policies to increase the number of mathematics and science credits required for graduation. However, the student participation rates in advanced science and mathematics courses remain small. For example, the rates for science course taking between females and males are equivalent except for more advanced courses such as physics. Female students continue to lead the enrollment in advanced biology courses (55%); whereas, boys continue to dominate advanced physics courses (60%; Blank & Engler, 1992). Information on underserved students' advanced course taking is more difficult to obtain, since these data are usually not available in national reports.

The second question, whether student achievement in science and mathematics improved in the last ten years, was tackled by Blank and Engler (1992) based primarily on data from the 1990 National Assessment of Educational Progress (NAEP). In this report, I expand on Blank and Engler's findings by comparing student achievement across grade levels, ethnicities, and socioeconomic status from two major national studies in the U.S. That is, in addition to NAEP, I draw from another large-scale assessment project, the First and Second Follow-up of the National Education Longitudinal Study (NELS). I also expand on Blank and Engler's analysis by contrasting the trends in achievement observed in national studies with those observed in national college-entrance exam reports. I draw from the American College Testing (ACT) Program and the Scholastic Aptitude Test (SAT) Annual Reports as well as from the Advanced Placement (AP) Program. A five-year block from 1990 to 1995 is primarily used in this study for comparing the trends in achievement across college entrance and advanced placement exams.

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[1]The actual impact on student achievement as a result of these reform efforts is currently under study.

Since equity is a fundamental construct guiding reform efforts, my goal was to find out not only how well students are performing in science, but to figure out how their participation in science-related/college-entrance exams has changed by gender, SES, and ethnicity. Furthermore, this report provides a more detailed analysis of academic performance by gender *within* ethnic groups. That is, instead of providing aggregated scores for "all" females or for only three "generic" ethnic groups, I provide a breakdown of the students' performance for males and females for each ethnic group whenever data was available.

In short, three broad questions guide this analysis:

a. What are the trends in student achievement in science by SES and gender within ethnic groups?
b. In what ways are the various national studies and reports on student achievement congruent with one another?
c. What do the answers to the above questions tell us about the state of science education in the U.S. and what suggestions do they provide for further study in terms of equity?

Reports and National Studies on Student Academic Achievement in Science

Several key government agencies are mandated by law to monitor students' educational progress, including the Office of Educational Research and Improvement in the Department of Education. Since 1969, this agency has sponsored the National Assessment of Educational Progress (NAEP). Every two years, NAEP evaluates the academic achievement of a nationally representative sample of elementary (Grade 4) and secondary (Grades 8 and 12) students. In spite of the limitations of NAEP, it is probably the most comprehensive tool for assessing students' cognitive achievement in science at critical grade levels (Mullis, Dossey, Campbell, Gentile, O'Sullivan, & Latham, 1994).

The Office of Educational Research and Improvement sponsors another important educational attainment project, the National Education Longitudinal Study (NELS; Horn, Hafner, & Owings, 1992; Owings & Peng, 1992; Rock & Pollack, 1995). The goal of this study was to measure cognitive growth in science over time. Furthermore, the NELS aimed to investigate the impact of school policies, family participation, and teacher practice on educational outcomes as the students developed and made challenging transitions from middle school, to high school, to college.

Several other agencies and studies are worth mentioning in more detail, but due to space limitations I will only briefly discuss below the trends in student achievement identified in the NAEP and NELS projects.

NAEP Trends

The NAEP study is designed to draw from a representative sample of the student population in grades 4 (age 9), 8 (age 13), and 12 (age 17). For example, in 1990, approximately 45,000

students per grade participated in the assessment. To facilitate interpretation of NAEP scores, students' performance is assessed according to a five-level proficiency scale (Mullis et al., 1994) as follows:

350 Student can infer relationships and draw conclusions using detailed scientific knowledge.
300 Student has some detailed scientific knowledge and can evaluate the appropriateness of scientific procedures.
250 Student understands and applies general information from the life and physical sciences.
200 Student understands some simple principles and has some knowledge, for example, about plants and animals.
150 Student knows everyday science facts.

Figure 1 illustrates that, compared to 1970 scores, the average science achievement for all students who participated in the 1992 NAEP (Mullis et al., 1994), was slightly higher for 9-year-olds, practically the same for 13-year-olds, and lower for 17-year-olds. (The standard errors for the estimated proficiencies are shown in Table 1.) Though it may not appear so, this bad news hides some good news. The overall science performance for all three age groups has actually been increasing since 1982.

In the last twenty years, according to NAEP (Mullis et al., 1994), the gap in science performance scores of students of African, Latino/a, and Anglo-European descent[2] closed modestly from 1977 to 1986. From 1986 to 1992, however, the achievement gains of underserved students seem to have stalled (see Figures 2 and 3). Furthermore, in spite of the improvement in the last ten years, the differences in performance among ethnic groups are still quite large for all three age groups considered. For example, in 1992 the gaps in proficiency scores among students from Anglo-European and African ethnic backgrounds were 48 points for 17-year-olds, 43 points for 13-year-olds, and 39 points for 9-year-olds (see Figure 2 and Table 2). In essence, these differences in scores mean that 17-year-old U.S. African students scored lower (256) than Anglo-European 13-year-olds (267). Similar differences were observed between U.S. Anglo-European and Latino/a students (i.e., 34, 30, and 34 points per age level respectively; see Figure 3 and Table 2). This means that 17-year-old Latinos/as scored only three points (270) above Anglo-European 13-year-olds (267). Nevertheless, as Figure 3 illustrates, the gap in achievement between Anglo and Latino/a students continued to shrink at ages 13 and 17.

The gaps in proficiency scores are less wide between U.S. Latinos/as and African students. However, the difference in performance between these two ethnic groups seems to be increasing in favor of 13- and 17-year-old Latinos/as (Figure 4).

The gender difference in the average proficiency scores between 13- and 17-year-old males and females seems to be decreasing (Figure 5). The differences in 1992 scores were 10 points for 17-year-olds, 4 points for 13-year-olds, and 8 points for 9-year-olds. Interestingly, while both males and females made some gains in the last decade, males have had higher scores at all three age

[2]The National Assessment of Educational Progress study only reports on the academic achievement of these three ethnic groups.

levels since 1970. This pattern should be interpreted with caution, since none of the differences in scores by gender and by age has been statistically significant since 1969-70.

Caution should also be followed when interpreting NAEP scores for Latino/a students. NAEP results are less reliable for Latinos/as due to the confusion some individuals face when trying to identify Latino/a children (Grissmer, 1996). That is, Latinos/as could be of any shade of skin color and/or could have any range of proficiency in English; therefore, it is difficult for local officials administering the NAEP tests to box Latinos/as into preset ethnic categories. In fact, it was not until 1977 (seven years after the first NAEP study) that the category of "Hispanics" was created to include all Latino/a students.

NELS Trends

In its base year, 1988, the National Education Longitudinal Study (NELS) involved 25,000 eighth graders from over 1000 randomly selected schools across the U.S. In addition, NELS gathered information from students, their parents, teachers, and school administrators. Three follow-up studies of the 1988 eighth-grade cohort have been conducted so far (in 1990, 1992, and 1994), and a fourth follow-up study is planned for 1998.

Findings from the NELS' base year and first follow-up support the same trends in achievement as those described in the NAEP reports. In other words, all ethnic groups showed improvement in their science performance scores in the first follow-up (Table 3; Scott, Rock, Pollack, & Quinn, 1995); however, the gap in achievement was maintained between Anglo-European and Asian students and African and Latino/a students. Moreover, the U.S. Anglo and Asian students showed the most gain in average scores (by half to three quarters of a standard deviation) in comparison to U.S. African and Latino/a students.

A similar pattern to NAEP scores was also observed for the NELS gender gap between grade 10 males and females (Table 3). In addition, males not only outperformed females in both the base year and first follow-up tests (by one-fifth of a standard deviation), but they also showed the larger gains in scores (Scott et al., 1995). Table 3 also illustrates the pattern of achievement according to the students' socioeconomic status. Students from the top SES quartile obtained higher scores and showed the most gains over time.

The NELS' second follow-up with grade 12 students was more detailed and allowed for a more in-depth analysis of academic growth (Green, Dugoni, Ingels, Camburn, & Quinn, 1995). Students were given four cognitive tests in reading, science, mathematics, and history/government. The scores were interpreted according to the following four-level proficiency scale:

Below Basic:	Does not demonstrate understanding of everyday science concepts.
Basic:	Understanding of everyday science concepts; "common knowledge" that can be acquired in everyday life.
Intermediate:	Understanding of fundamental science concepts upon which more com plex science knowledge can be built.

Advanced: Understanding of relatively complex scientific concepts; typically requir ing an additional problem solving step.

Figure 6 illustrates that slightly over 28% of U.S. Asian students scored at the Advanced level of science proficiencies, followed closely by 26.3 % of the Anglo-European students. But only 11% of Latinos/as and 5.4% of African students attained the Advanced proficiency level. This pattern reverses dramatically at the Below Basic level with 34.5% of African and 25.8% Latino/a students scoring at this mark. Note that the achievement gap is narrower among all underserved students at the Intermediate level, (Table 4 includes the statistical data for the information shown in Figures 6 to 8.)

In relation to gender differences, unfortunately just as with NAEP, NELS does not provide data on the performance score distribution by gender within ethnic groups. However, the differences in achievement between males and females are shown in Figure 7. Males dominate the Advanced proficiency level by almost 8 percentage points, whereas, females are slightly ahead at the Intermediate level by almost 2.5 percentage points. By combining the percentage of students who scored at the Basic and Below Basic levels, we see that 49% of the female high school seniors do not understand fundamental principles of science, whereas 44% of the males are in the same predicament (see Table 4 and Figure 7).

This trend in achievement is also shown in the score distribution according to socioeconomic status. That is, almost 68% of students from low income families and 47% of students from medium-income families do not appear to understand the fundamental principles of science (see Figure 8 and Table 4). On the other hand, 75% of high-income students scored at the intermediate and advanced proficiency levels.

Findings from NELS follow-up studies no doubt produce a great deal of valuable information on the experiences of middle schoolers as they progress through school and through college. However, the same problems related to identifying Latino/a students mentioned above for NAEP also occur to NELS. In addition, one of the drawbacks of longitudinal studies such as NELS is that it provides a less reliable assessment of students' cognitive performance due to the short length of time allocated for the science test (Rock & Pollack, 1995). That is, NELS allows only 20 minutes for students to answer the 25 multiple-choice question section; the NAEP science component has 63 multiple-choice questions at age 9, 83 multiple-choice questions at age 13, and 82 multiple-choice questions at age 17 (Mullis et al., 1994).

In sum, the pattern in academic performance by gender, socioeconomic status, and ethnicity observed so far in NELS is congruent with that observed in NAEP, even though there are marked differences between the two studies. One significant drawback in interpreting the results of these national studies is that they do not provide a breakdown of the achievement scores by gender within ethnic groups. Therefore, it is not possible to determine, for example, whether the achievement level of U.S. African girls is different from that of U.S. African boys, or different from that of females from other ethnic groups. Similarly, it is not possible to determine whether Mexican boys are achieving at a higher rate than Puerto Ricans or than students from other Latino groups. It is essential that more detailed information be gathered and made readily available in order to effectively assess student achievement in terms of equity. This information

is especially imperative when we consider how rapidly the U.S. population is changing. For instance, according to the 1990 U.S. census, Mexicans constitute the largest ethnic group of the Latino/a population (about 63%), Other Latinos (peoples from various Latin American countries) represent the second largest group (at 14%), and Puerto Ricans constitute the third largest group (at 11%). Also projections in population growth (Day, 1993) estimate that Latinos will constitute the second largest ethnic group in the U.S. by the year 2010.

Given the trends in student achievement observed in NAEP and NELS, and given the limitations of these studies, how do these trends compare with the trends in achievement observed in the two commonly used college entrance exams in the U.S.: the American College Test (ACT) and the Scholastic Aptitude Test (SAT)? How do these trends compare with trends in achievement in advanced placement (AP) exams? Do college entrance exam annual reports provide more detailed information on student achievement by gender within ethnic groups? These questions are the focus of the next sections.

ACT Trends

The American College Test (ACT) is widely used by many universities and colleges as a predictor of postsecondary education success.[3] Students are evaluated on the basis of their performance in four subject areas: English, Mathematics, Reading Comprehension, and Science Reasoning.[4] The ACT Program also reports the students' composite scores, as well as compiling some information on the students' career goals and academic, socioeconomic, and ethnic backgrounds.

The ACT annual reports include information on the performance of students who followed a core sequence of high school courses and those who did not. The core sequence consists of four years of English, three or more years of mathematics, three or more years of social sciences, and three or more years of natural sciences. For the purpose of this analysis, the average score for both core-sequence and less-than-core-sequence students combined is used. Furthermore, since the focus of this study is on trends in student achievement in science, only the students' scores on the ACT's Science Reasoning (SR) component from 1992 to 1995 by gender within ethnic groups will be discussed. The ACT does not provide a breakdown of the students' average scores by SES. Also, since a new Science Reasoning Test was introduced in 1991, comparisons of the students' performance from previous years is not possible.

The SR component was designed to assess the candidates' interpretation, evaluation, reasoning, and problem-solving skills in the natural sciences. As Figure 9 shows, trends in the Science Reasoning scores reveal a very similar pattern to that discussed above for the national studies. Figure 9 also contrasts the overall national mean scores with the national mean scores for males and females within ethnic groups. (Table 5 shows the national male and female mean scores plus

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[3]ACT officials point out that test results should not be interpreted as representative of the college-bound student population, because ACT test-takers are usually overrepresented in some areas of the country. For instance, a larger percentage of ACT takers come from the Midwest, Rocky Mountains and Plains, and the Southern areas of the USA.

[4] The score scale for all tests is from 0 to 36 points.

the standard deviations.) For the past four years, all underserved students have scored[5] below the national mean. The ethnic groups are shown in Figure 9 by test performance from highest to lowest (students who are classified as "other" by the ACT program, or who did not select an ethnicity category are not included in this analysis.) As can be observed, the pattern has changed little in the last four years. Similarly, females from all ethnic groups continued to score below the national mean or, in the case of Anglo-European and Asian females, at the national mean level. Anglo and Asian males continued to dominate on the top-score range with consistently similar achievement patterns over time. The scores of Anglo and Asian females were also higher than those of females from other ethnic backgrounds; however, Anglo and Asian females maintained a lower score than their male counterparts.

Even though the total number of test takers increased between 1992 and 1995, the percentage of Anglo test takers decreased from 73% in 1992 to 69% in 1995 (see Table 6). By contrast, the number of underserved students taking the ACT increased from 1992 to 1995, but their overall percentage distribution in the population of test takers remained the same (Table 6). In addition, Figure 10 shows the percentage distribution of students in schools by ethnicity from 1976 to 1992. A comparison of percentages in Figure 10 with those in Table 6 demonstrates that underserved students are grossly underrepresented in the test-taking population. While Anglos constituted 66.7% of the total number of students enrolled in public schools, they represented 69% of all ACT-takers. Latinos/as represented 12.3% of the school population, but they constituted only 6% of the total ACT student population in 1992. Asian students were well represented at 3% of the ACT population while they formed 3.5% of the total U.S. public school enrollment. This issue will be revisited with SAT and AP tests below because it raises a critical question: What do these trends in achievement indicate about the access underserved students have to postsecondary science education?

SAT Trends

The Scholastic Aptitude Test (SAT) is another widely used indicator of potential academic success by universities and colleges (College Board, 1995a). Many college-bound students are required to take the verbal and mathematical components of the test. The verbal section assesses students' reading comprehension and vocabulary skills. The mathematics section measures students' reasoning skills to solve arithmetic, algebra, and geometry problems. The score range for each component is from 200 to 800 points.

Although the SAT does not include a science content or scientific reasoning component, achievement on this test is discussed here because the students' performance pattern on SAT tests shows strong similarities with the patterns in student science achievement observed in NAEP, NELS, and ACT reports. Notwithstanding the obvious differences in test formats, age groups, and academic preparation of the students involved in these studies, the overall pattern in academic performance is very similar across tests and across age, regardless of school subject. To better understand this pattern, a more in-depth analysis of the students' performance is

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[5]The American College Testing Program did not have available any statistical data on the performance of minorities by gender within ethnic group. ACT only reports overall mean scores plus standard deviations for males and females and overall mean scores for ethnic groups.

necessary. Since the Scholastic Aptitude Testing Program also compiles--and makes readily available--information on the students' academic, ethnic, and socioeconomic backgrounds, further study of the links between academic performance and social factors is possible.

A first glance at Figure 11 indicates that in 1995 the means of all underserved groups were below 482, the national mean on the Math SAT. Anglo-European and Asians students were again at the top of the scale and African students at the bottom, with First Nations people and Latinos/as in between. In general, this trend is the same from 1990 to 1995, the five-year block being considered in this study. In fact, for most ethnic groups, this pattern in SAT Math achievement has not changed in over a decade, even after some gains in scores across ethnic groups (National Science Foundation, 1994).

Figure 11 shows the distribution of the top tenth mean scores attained by students for each ethnic group.[6] One would expect male and female students whose scores are within the top tenth for each ethnic group to have scores above the national mean for their gender. However, the mean scores of the top tenth of Mexican, Puerto Rican, and African females are below the national mean score for females. Similarly, the mean scores of the top tenth of Puerto Rican and African males are below the national mean score (see Figure 11).[7] In 1995 the difference between the national mean score and the top tenth scores of females ranged from 130 points for Asians to 56 points for First Nations students, to 17 points for Mexican females. Similarly, the difference in scores between the national mean and the top tenth of Puerto Rican females was 6 points below the national mean. African females scoring at the top tenth for their ethnic group still scored 14 points below the national mean. This in fact appears to be an improvement from the previous years. On the other hand, the difference between the national mean score and the scores of the top tenth of males ranged from 96 points for First Nations students to 177 points for Asians; the differences for the top tenth of Mexican, Puerto Rican, and African males were 74, 42, and 24 points, respectively. These differences are even more striking when one considers that African and Latinos are the second largest ethnic groups in this country.

Another important finding is the consistent pattern of women's lower scores on Math SATs in the last five years. Figure 12 illustrates the overall percentage distribution of SAT takers by gender within ethnic groups. As can be observed, females constitute 59% of the test-taking population for U.S. African students compared to 51% for U.S. Asian students. One might expect that the greater proportion of females in the pool of test takers would have a lowering effect on the average test scores. However, this should not be the case when the proportion of female students scoring in the top tenth was also higher for all ethnic groups. In fact, U.S. Anglo-European, First Nations, and African females outnumbered their male counterparts in their respective top tenth categories by 3 to 5 percentage points. Furthermore, Figure 13 shows how substantial the overall growth in the underserved SAT test-taking populations has been in the last five years. While all Latino/a groups showed the greatest growth, the First Nations and Anglo students had a considerable drop in numbers. The Anglo female population showed the smallest growth (0.8%)

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[6]Note that the scores in Figures 10 and 12 are organized from highest to lowest score and by gender within ethnic groups.

[7]Statistical data for all SAT scores were not available.

in the last five years. Nevertheless, as mentioned earlier, the overall trend in academic performance remains the same by gender within ethnic group.

Notwithstanding the shifts in the test-taking population shown in Figures 11 to 13, and the increase in underserved test takers, the overall distribution of test takers per ethnic group has changed little for underserved students (see Table 7). Compared to 1990 figures, the Latino/a population has shown the most growth at 2%, and the Anglo population showed the only drop in numbers (by 4%). Asian and Anglo students continue to be overrepresented in relation to their relative numbers in the overall public school student population, and U.S. Latinos/as and African students are grossly underrepresented (see Figure 10 and Table 7).

One of the principal factors researchers believe influence underserved students' achievement in science is tracking. Considerable evidence suggests that tracking—among other forms of institutionalized racism (Sleeter, 1994; Grant & Sleeter, 1986; Atwater, 1993, 1994)—has a cumulative effect (Oakes, Ormseth, & Campbell, 1990). I am not disputing this claim, but it is curious to observe that, even though female students have usually been reported to take more, and do better in, English classes (NSF, 1994), the same pattern in performance mentioned above is maintained in the Verbal SAT (see Figure 14). In other words, even though the gap in scores is lower, females from most ethnic groups with scores within the top tenth range still scored lower than their male counterparts on the Verbal SAT. In addition, similar to the performance scores on the Math SAT, the top tenth African, Puerto Rican, and Mexican students scored at or slightly above (428) the national mean. One would expect that many of the social and institutional factors that impact on underrepresented students' performance do not have the same effect on those students scoring at the top tenth from each ethnic group. For instance, one would think that underrepresented students who are high achievers are highly motivated to succeed, their parents have higher expectations of them, and/or they probably come from middle- to high-income families. Why then would even the top students from some ethnic groups still continue to perform below the national average? No conclusive inference can be drawn at this time due to the lack of statistical data on the students' scores and the lack of qualitative data on the personal backgrounds of these students. However, findings from the 1982 High School and Beyond and the National Longitudinal Study of the Class of 1972 studies make me believe that poor reading skills may be associated with the poor performance of many underserved students in college entrance exams. For instance, Adelman (1995, 1996) explains that the proportion of U.S. Anglo students who had taken remedial reading courses,[8] and who had completed at least one term of semester credits by the time they turned 30 barely changed (going from 6 to 7%) between the 1972 and 1982 samples. On the other hand, the proportion of Latinos taking remedial reading classes rose from 10% to 17%. The proportion for Latinas changed unsubstantially from 11% to 13%. The worst case scenario was for U.S. African females; that is, the increase was from 20 to 41%. For U.S. African males the proportion changed from 21 to 33%.

Considering the small percentage of underserved students who manage to attend college, the disproportionate number of them who must take remedial reading classes points to the need to explore this issue in more depth. One useful place to start could be the nature of the college

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[8]Remedial courses are defined by Aldelman (1996) as those courses considered to provide only basic, tutorial or developmental information.

entrance exam questions and the purposes of these tests. In short, whose interests do these entrance tests really serve?

We may begin to shed some light on this issue by taking a closer look at the unique group of high achievers who take advanced placement exams. What would the trend in achievement look like for traditionally underserved students on the science advanced placement exams? How different would this trend be in the last five years compared to the trends in achievement for NAEP, NELS, ACT, and SAT? These questions are examined below.

AP Trends

The Advanced Placement (AP) exams—like the Scholastic Aptitude Test (SAT)—are another nationwide assessment tool sponsored by the College Board (1995a). The AP program is different, however, in that it also involves the monitoring of the college-level introductory courses designed to prepare students to take the exams. To this end, the AP Program also provides professional development workshops and curriculum materials for teachers. In the 1994-95 school year, over 2,900 high schools offered college-bound students advanced credits in 26 different subjects. Of these subjects, students could earn advanced credits in postsecondary introductory science courses such as biology, chemistry, and three different physics areas (general physics, mechanics, and electricity and magnetism). The College Board uses the following five-level scale for interpreting the students' standing:

5 Extremely well qualified
4 Well qualified
3 Qualified
2 Possibly qualified
1 No recommendation

Since AP exams cater to highly motivated college-bound students, these exams are not the best indicators of participation and success in science. Nevertheless, these types of assessment (along with the SAT or ACT) have the power to open or close doors for "selected" college-bound students. As stated in the College Board's *Guide to the Advanced Placement Program* (1994), the AP program "identifies and attracts highly motivated students who have succeeded in rigorous, college-level courses and demonstrated their ability through demanding national examinations" (p.10). In 1995, over half a million students took AP exams, and twice as many students took SAT exams (1,068,000) or ACT exams (945,369). These three types of examinations serve as doors to postsecondary education—with the AP courses and exams serving not only as a door but as a "master key" as well. Therefore, it is important to examine who benefits the most from AP preparation.

While the College Board and others have claimed significant increases in the number of exams taken by students from all ethnic groups (College Board, 1995a; Blank & Gruebel, 1995), we need to be aware that a difference exists between the number of exams taken and the number of students taking exams. The figures indicating underrepresented student participation in the AP Program may appear higher than they actually are unless the absolute number of test takers is considered, because one student may take AP exams for different subjects. In any case, the

percentage of underrepresented students has indeed increased in the last five years up to 26% of the total test-taking population in 1994 (College Board's *Guide to the AP Program*, 1994). However, to truly appreciate the significance of this increase and its impact on underrepresented students' access to advanced placement opportunities, a detailed examination of the AP trend in science achievement is necessary.

To this end, I conducted a simple frequency analysis. I aggregated the results for all AP science tests (Biology, Chemistry, Physics B, Physics C - Mechanics, and Physics C - Electricity & Magnetism). Figure 15 shows the percentage of all students who scored 3 or higher according to gender within ethnic groups. I found that out of the male students who took AP science exams and scored the passing grade of 3 or higher in 1995, 21.8% were of Asian descent. This figure is again considerably larger than expected when the projected Asian population for 1995 constituted only 3.7% of the total U.S. population (Day, 1993; see Figure 16). On the other hand, the proportion of U.S. African male students who scored 3 or higher was only 1.5% (Figure 15), but the estimate of people living in the U.S. of African descent was 12.6% of the total population (Figure 16). The numbers for Latinos/as are just as alarming. Of those males who scored 3 or higher, only 0.3% were Puerto Rican, 1.2% were Chicanos and 1.9% were from Other Latino/a backgrounds; however, Latinos/as are estimated to be 10.2% of the total U.S. population. First Nations people represented 0.4% of all male students who scored 3 or higher but constitute an estimated 0.8% of the total U.S. population in 1995. For Anglo-European students, a better match is observed between the number of students doing very well and their proportion in the overall national population. That is, 72% of all male students scoring a 3 or higher were Anglo-European. This figure is closer to the estimated 83% of Anglo-Europeans living in the U.S. in 1995. (Even though the participation of U.S. Anglo-European students appears to be satisfactory in relation to their proportion to the rest of the U.S. population, this figure is somewhat misleading. In fact, only 6.6% of all U.S. 18-year-olds actually take AP exams, and only 4.4% pass them. On the other hand, the participation of students on advanced placement examinations from other countries such as Japan, Germany, France, England, and Israel ranges from 25% to 50% of the total student population (Britton & Raizen, 1996).

The overall results for female students within ethnic groups are very similar to those reported for males, but with some important exceptions. In spite of their low numbers, a higher percentage of African females (about 20.4% more than males) are passing AP science exams (see Figure 15). In fact, the number of African females has been steadily increasing during the five years considered for this study. Figure 17 indicates that African females had an increase of 122% in successful AP participants from 1990 to 1995. A similar pattern is observed for all female AP test takers. Puerto Rican females showed the greatest increase (177%) in successful participation, and Chicanas follow closely with an increase in participation of 170% over 1990.

U.S. Asian females have consistently shown a slightly higher proportion in absolute numbers than males (Figure 15). In addition, since 1990 the total percent increase in successful Asian females students was nearly double that of Asian males (Figure 17). All males from the various ethnic groups have had a substantial increase in absolute numbers, with Latinos/as under the "Other Latino/a" category having the largest increase (206%) since 1990. Nevertheless, perhaps due to their small numbers compared to the number of Anglo students, the increased

participation of underserved students did not disrupt the achievement distribution pattern shown in Figure 15.

These results further support the urgent need to conduct more critical and in-depth analysis of the academic performance of males and females within various ethnic groups, especially when current reports portray a relatively optimistic picture that could be misleading. Although, the participation of underrepresented students in AP exams has increased, we must continue to ask why only 4% of those students who successfully complete AP in the sciences come from ethnic backgrounds (Latinos, African, and First Nations) representing over a quarter of the U.S. population. We could begin to learn a great deal by investigating questions such as, Why do 20.4% more U.S. African females than African males successfully complete AP science exams? What are the social and institutional factors that influence these students to their advantage?

Discussion and Recommendations

In this paper, I provided a meta-analysis of trends in student achievement in science by SES and gender within ethnic groups. A brief summary and discussion is provided below, followed by some recommendations and suggestions for further study.

Trends in Student Achievement by SES and Gender Within Ethnic Groups and Across Studies

According to the national reports and studies considered in this paper, there is cause for cautious celebration regarding student achievement in science. The National Assessment of Educational Progress (NAEP) studies, for example, suggest that the gap in achievement between traditionally underserved (i.e., females, Latinos/as, U.S. African, and First Nations peoples) and Anglo and Asian students has narrowed in the last ten years. In addition, I have provided some evidence that the absolute numbers of underserved students taking more high school science courses and taking college entrance and advanced placement exams have increased in the last five years.

However, when the overall quality of performance is considered (i.e., how well underserved grade 4 to grade 12 students have been performing in the sciences for the last 20 years in NAEP studies), the insidiousness of the achievement pattern becomes apparent. Anglo-European and Asian students continue to substantially outperform underserved students. First Nations people, Other Latinos/as, and Mexican students scored lower than Anglo and Asian students in that order, and Puerto Rican and African students continue to be at the bottom of the scale. Poor students consistently attain lower scores than children from middle and high socioeconomic families. The figures and tables included in this report clearly show that this pattern of performance in science achievement is very congruent across national studies and reports. That is, even though the nature of studies such as NAEP and the National Education Longitudinal Study (NELS) is so different from SAT, ACT, and AP exams, all these data sets indicate the same pattern in student achievement regardless of age and grade level.

Therefore, significant interventions, such as increasing the number of math and science credits students must take before high school graduation (National Commission on Excellence in Education, 1983), have had little impact on trends in student achievement. This situation

continues to have obvious ramifications for underserved students' career options and access to postsecondary institutions.

Notwithstanding, different questions emerge and more can be learned when we do more than "gap gaze" (Bill Clune, 1996) at student achievement. In other words, we need to look not only at quantifiable improvement in student achievement by gender, SES, and ethnicity, but we need to look also at the quality of these improvements. Insights from this approach may add to our understanding of how to make current educational reform efforts more effective than those attempted in the past.

Below are a few examples of the kind of information that can be gathered when we assess trends in student achievement with other than the traditional yardstick:

- When the performance of Latino/a students is broken down by ethnic groups, we can observe that Puerto Ricans consistently score lower on the Math and Verbal SATs (Figures 11 and 14). However, students who fall under the category of "Other Latino/a" (children with ethnic roots from various Latino countries) consistently perform better than, or at the same level as, Mexicans and Puerto Ricans on the SAT and on the ACT science reasoning section.
- Another persistent pattern is that females from all ethnic groups and from all age levels scored lower than their male counterparts in all reports and national studies considered here. For example, even Puerto Rican, African, and Mexican females with the top tenth scores for their corresponding ethnic groups scored lower or only slightly higher than the national SAT Math mean score. Unfortunately, statistical data are not available to further study the strength of some of these findings. The Scholastic Aptitude Test, the American College Testing Program and the Advanced Placement Programs do not provide any statistical analyses by gender within ethnic groups or/and by socioeconomic status.
- The absolute number of U.S. Anglo-European students taking college-entrance exams has decreased for SAT and ACT (up to -4.0%; see Tables 6 and 7), while the absolute number of underserved students (especially females) has increased substantially. This pattern is congruent with the shift in population demographics in the U.S. Figure 18, for instance, shows that the Latino student population is the fastest growing ethnic group in the country. The total number of Latino students increased by 6% in 1995 over 1976 figures, while, the total number of Anglo-European students decreased by 9%.
- In spite of the substantial changes in student demographics, the underrepresentation of underserved students in college entrance exams remains strong. Furthermore, the distribution of test-takers by ethnic group also shows very little change. For example, Table 6 indicates that the percentage of U.S. African students who took the ACT in 1995 is the same as in 1990. Similarly, the percentage of African students who took the SAT in 1995 increased by 1% compared to 1990. These findings, compounded by the even smaller fraction of underserved students who have successfully taken Advanced Placement exams, raises serious concerns about who really has access to postsecondary science education in the U.S. (This issue will be discussed in more detail below.)

- Caution must be observed in reading recent reports claiming that 26% of students who took AP tests in 1994 came from traditionally underserved ethnic groups. Similarly, we must be more critical of reports indicating that the proportion of all females taking AP science exams was 44% (in that same year). The data shown here illustrate that a richer story is revealed when the performance of those students who score 3 and above is broken down by gender within ethnic groups. Furthermore, as shown in Figures 15 and 16, 22% of all the students who took AP science exams and scored a 3 or higher were of Asian descent, while only 4% of the successful test-taking population came from what constitutes almost a quarter of the total U.S. population (i.e., First Nations, Africans and Latinos/as).
- Even though the participation of underserved students in AP science exams remains very small, the percentage change of U.S. African and Puerto Rican females who passed AP science exams was double that of their male counterparts in 1995 compared to 1990 (see Figure 17). Similarly, with the exception of First Nations and Other Latinas, the total number of females is almost double the number of males who scored a 3 or higher on AP exams. Puerto Rican, Chicanas, and U.S. African females have shown the greatest increase in successful participation over 1990 figures. Moreover, 20.4% more U.S. African females successfully complete AP science exams than their male counterparts in 1995.

Recommendations and Possible New Directions

According to the National Education Goals Panel, we now have only four years left to help our students become "first in the world in mathematics and science achievement" (National Education Goals Panel, 1995, p. 12).This is Goal 4 of the six national goals in education President Bush and all the U.S. Governors established in 1990 (two more goals were added in 1994 with the passage by Congress of the Goals 2000: Educate America Act). Goal 3 is that all U.S. students will leave grades four, eight, and twelve with tangible competency in core subjects such as mathematics and science. On the basis of the data in this paper, we have made some progress, but we are far from reaching the Educate America goals, especially when there is so much we do not know due to the kind of (and lack of) data we collect about our students.

One way to address this issue is by stressing the importance of national studies on achievement to recognize that there are more than three major ethnic groups in the U.S., and that there also are two genders within each ethnic group. National studies such as NELS and NAEP and most annual reports such as the Council of Chief State School Officers' Science & Math Indicators (Blank & Gruebel, 1995), National Education Goals Panel, ACT, and SAT do not provide a breakdown of student performance by gender within ethnic group, a welcome exception was the College Board's Advanced Placement Annual Reports. In fact, there is a tendency to write about minorities' educational progress as if all ethnic groups and all females within ethnic groups are the same. This approach sometimes creates an inflated sense of progress as indicated above with the AP exams.

There is also a need to reconceptualize the factors we have come to believe are responsible for the pervasive gap in academic performance between underserved students and U.S. Asian and Anglo students. Several explanations have been proposed to account for this pattern, including

tracking, teachers' lower expectations, parents' education and lack of involvement in school life, family structure, pressure from peers, family's low income, language barriers, and so on. In fact, Peng and Hill (1995) found that each of the social and institutional factors that may affect underserved students' achievement had a much smaller impact when considered individually. On the other hand, when the school, home, and individual factors were considered jointly, these factors could account for as much as 45% of the difference in scores between underserved and Anglo and Asian students.

Researchers tend, however, to focus only on what underserved students lack and not on what they have accomplished. In the last 20 years, we have gathered a great deal of information on the social and institutional factors that negatively affect the progress of underserved students (NSF, 1994). What we need now is to find out more about how some marginalized students have managed to succeed in spite of all the obstacles. It seems that a good place to start is with those underserved students who take and successfully complete the elite Advanced Placement exams in science.

For example, Coley and Casserly (1992) conducted a study with AP students from eight high schools, where 40% of the student population was from diverse ethnic and SES backgrounds. The sample consisted of a total of 509 students who scored a 3 or higher on AP exams. Thirty-two percent of the students were of Anglo-European descent. The goal of the study was to collect information on the students' families and socioeconomic characteristics as well as on their role models, career goals, and so on. Coley and Casserly found that these students' professional goals were high; "more than two-thirds planned to pursue graduate degrees" (p. 35). Coley and Casserly also reported that two-thirds of the students perceive the availability of financial aid as one of the very important or deciding factors influencing which college they could attend. The students' top career choices were business and economics (24%), followed closely by the fields of medicine (22%), science and mathematics (22%), law (17%), and engineering (15%).

Patricia Gandara's (1996) study with 50 successful Latinos and Latinas who completed Ph.D., J.D. or M.D. degrees also serves as an example of the need to reconceptualize our assumptions. For instance, social factors such as English as a second language at home and family structure are traditionally reported as negatively affecting underserved students' progress at school. However, for the Chicanos/as participating in Gandara's research, these factors were sources of strength. Furthermore, most of the participants in Gandara's research were Chicanos/as from all over the U.S. who were born in the barrios and the fields. Gandara describes her work well when she explains that "rather than an investigation of extraordinary individuals, this is a study of extraordinary outcomes for individuals from less than ordinary circumstances" (p. 11). Of interest to this study is the fact that of 30 men and 20 women who completed graduate degrees, only two, one male and one female, completed Ph.D. degrees in science.

A qualitative and longitudinal study with students like those who participated in Coley and Casserly's and Gandara's studies described above could provide much more information on the factors that obstruct and/or facilitate highly motivated, underserved students' pursuit of science-related careers.

Other important aspects to consider when trying to make sense of who has access to postsecondary science education are the value and purpose of college entrance exams. Even though exams like the SAT, ACT, and AP are not the best indicators of students' science understanding, they are good indicators of who has access to—and choices of—college. Given the score distribution by gender within ethnic groups presented in this paper, and given the participation of underrepresented students in college-entrance exams, who actually makes the cut? Who actually meets the selection criteria of top colleges and universities?

Using data from the NELS:88 Second Follow-up study, Owings, McMilen, and Burkett (1995) determined that only 5.9% of all college-bound students in the sample[9] met the demanding selective criteria of the "most competitive colleges." Competitive colleges were identified by the authors as having the following student entrance criteria: (1) a high school average (GPA) of 3.5; (2) an SAT score of 1100 or higher; (3) a high school course-sequence that included four English credits, three social studies credits, three science credits, three mathematics credits, and two foreign language credits; (4) positive teacher comments; and (5) active involvement in two or more school-related extracurricular activities. Although many colleges have different admission criteria and college-bound students have other options such as two-year colleges, it would be very useful to find out how many underserved students actually meet the selective criteria of "competitive" colleges, especially when even in a substantially reduced admission criteria scenario, only 19.5% of college-bound students would meet the requirements. Owings et al. (1995) designed a model to estimate the percentage of students who could get into college if the admission requirement were reduced to include: (a) GPA of 3.0; (b) SAT score 950; and (c) three credits in English, two credits in social studies, and less than two credits in foreign languages. This model increased the proportion of students who met the college selection criteria from 5.9% to 19.5%, leaving around 80% of college-bound students ineligible for admission.

Considering the small percentage of underserved students who actually participate in college-entrance examinations and Advanced Placement programs, and considering the attack on affirmative action programs in places like the University of California, the small number of students who met the college selection criteria in Owings et al.'s model explained above is cause for alarm. Therefore, intervention programs to assist underserved students improve their academic performance and participation in the sciences are definitely needed, but the college entrance exams—the doors to postsecondary education—need also to be checked. Little can be gained from intervention programs to enhance achievement and participation if the few underserved college-bound students who made it through high school cannot gain admission to recognized colleges due to high admission criteria and competition.

Closely linked to the issue of equity in science is the need to look at the relationship of college-entrance exams and underserved students' reading skills. As previously reported, Adelman (1996) found that a high percentage of underserved students take remedial reading courses while attending college. This factor, coupled with the fact that some underserved students who score within the top tenth for their ethnic group in the verbal SAT still score at or below the national

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[9]Out of a pool of 13,173 students who completed high school in Fall of 1992, 6,760 were classified as "college-bound" students with complete transcript data. The percentages reported here include only the students under the college-bound category

average, demonstrates the need for further research on language skills. Insights from such studies would provide suggestions for focusing available resources on the areas that matter most.

Finally, by moving away from the deficit model of reporting on underserved students as only low achievers, and by moving away from strict yardstick comparisons between "Asians and Whites" and "the Other," we may be able to learn a great deal from those traditionally marginalized students who have identified the "rough edges" of schooling and have learned to successfully navigate through them. This is not to say that we should ignore the socioeconomic obstacles some marginalized students face. On the contrary, a longitudinal study with underserved students who have been successful in science in spite of the odds may provide us with new insights. We may identify the factors that, from the students' point of view, have the most impact on their academic growth. It is time to start counting not only the runners, but the runners determined to run even without shoes.

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